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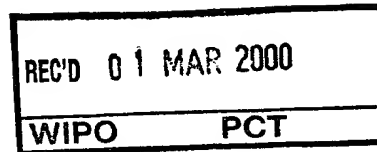
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I, KAY WARD, TEAM LEADER EXAMINATION SUPPORT & SALES hereby certify that annexed is a true copy of the Provisional specification in connection with Application No. PP8039 for a patent by FARALLON PTY LTD filed on 06 January 1999.

I further certify that the name of the applicant has been amended to NU-LEC PTY LTD pursuant to the provisions of Section 113 of the Patents Act 1990.

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*K Ward*

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## **PROVISIONAL SPECIFICATION**

Invention Title: "PRODUCT AND PROCESS"

The invention is described in the following statement:

TITLE"PRODUCT AND PROCESS"FIELD OF THE INVENTION

5           The present invention relates to an improved method for incorporation of a high voltage vacuum interrupter into a moulded polymeric body and a vacuum interrupter so housed.

DESCRIPTION OF RELATED ART

10           PCT/AU94/04835 (WO 94/25973) describes an integrated high voltage system for switching power and sensing conditions within power lines. The system operates as a recloser or sectionaliser in power distribution networks.

          The system comprises a vacuum interrupter initially pre-cast into  
15   an engineered, highly filled cycloaliphatic epoxy resin containing from about 68-73% of a ground silica filler. The epoxy encapsulated vacuum interrupter and other components are then encapsulated into a highly filled polyester based polymer concrete such as Polysil (Registered trade mark of The Electric Power Research Institute).

20           The coefficient of thermal expansion of the initial encapsulant is said to closely match that of the other components thereby avoid stress cracking at the engineered epoxy/Polysil interface.

          US 5808258 describes an encapsulated high voltage switch

comprising an elastomeric housing having a prefabricated tubular dielectric reinforcing element moulded or press fitted therewithin. A ceramic vacuum interrupter is disposed within the reinforcing element and surrounded by a dielectric filler material such as petroleum-based and silicone-based greases, silicone gels or RTV elastomers such as silicone rubber. The space between the vacuum interrupter and the tubular reinforcing element may be loosely packed with the filler material and mineral oil or silicone oil is introduced to swell the polymeric filler to provide a void free interface with the ceramic vacuum bottle.

US 5597992 describes a ceramic vacuum interrupter surrounded by a layer of polyurethane and encapsulated in a cycloaliphatic epoxy resin body.

PCT/US97/15936 (WO 98/11582) describes a method for casting a ceramic vacuum interrupter in an epoxy encapsulation.

This document deals with a method and apparatus for overcoming a stated prior art problem of direct epoxy encapsulation of polyurethane coated vacuum interrupters of the type described in US 5597992 above wherein differing coefficients of expansion of the polyurethane and epoxy materials lead to stress cracking in the epoxy encapsulant.

As the prior art demonstrates, there is an ongoing need to improve the method of incorporating ceramic vacuum interrupters in dielectric housing materials to reduce manufacturing costs and otherwise to improve the reliability of high voltage switching mechanisms in the field.

The prior art also demonstrates a pre-occupation with a ceramic vacuum interrupter which is permanently embodied in the epoxy housing by encapsulation at the time of manufacture of the housing.

While the prior art encapsulated vacuum interrupters may be  
5 generally effective for their intended purpose there are severe shortcoming and limitations associated with the final step of encapsulation of the vacuum interrupter in the interrupter housing.

PCT/US94/04835 and PCT/US97/15936 in particular deal with the problems which can arise due to difference between the respective  
10 coefficients of thermal expansion of encapsulating materials and the ceramic vacuum interrupter housings.

PCT/US94/04835 seeks to overcome the thermal stress problems by utilising highly filled polymeric primary and secondary encapsulation materials having similar coefficients of thermal expansion.

15 PCT/US97/15936 utilises an expanded silicone rubber sleeve around the vacuum interrupter body to cushion the stresses in the epoxy encapsulation as it shrinks upon cooling. This specification claims that the expanded silicone has a coefficient of thermal expansion within the range of  $60$  to  $90 \times 10^{-6}$  mm/mm/°C and is relatively constant over the range of  
20 from -40°C to 160°C.

A possible disadvantage in the use of a preformed sleeve of elastomeric material is the difficulty in consistently obtaining a void free interface between the silicone rubber sleeve and the surface of the



ceramic vacuum interrupter. Even when the sleeve is progressively shrunk on the ceramic surface from the middle towards the opposite ends, it is possible that there remains at least a mono-molecular layer of air which can provide a tracking path for partial discharging over the surface of the ceramic interrupter body.

It is stated in this specification that a liquid silane adhesion primer may be applied to the ceramic interrupter body or to the inner surface of the sleeve before the sleeve is applied to the interrupter body. Thereafter the bottle and sleeve are allowed to rest for 24 hours to enable the liquid silane primer to diffuse through the sleeve to enhance the bond between the sleeve and the epoxy encapsulation.

While a silane primer is required to enhance the ceramic/silicone bond, again it is considered that this technique can reduce that bond and actually draw air into the interface region as the liquid silane solution diffuses into the silicone rubber thereby creating a partial vacuum.

One of the greatest disadvantages of prior art epoxy encapsulated vacuum interrupters is that the electrical integrity of the encapsulating body cannot be tested until the assembly is complete. If the assembly is found to be deficient, due to air voids etc., the entire assembly, including an expensive, otherwise functional vacuum interrupter must be discarded.

Similarly another major disadvantage arises when the vacuum interrupter itself fails in service. Because it is encapsulated in the epoxy body, it is not possible to simply replace the interrupter and again the

entire assembly must be discarded.

### OBJECTS AND SUMMARY

It is an aim of the present invention to provide an effective method  
5 of locating vacuum interrupters in an epoxy housing.

It is a further aim to provide, in a high voltage switching system, a  
replaceable vacuum interrupter.

According to one aspect of the invention there is provided a  
method of incorporating a vacuum interrupter into a housing, said method  
10 comprising the steps of:-

moulding, on to a surface of a vacuum interrupter, a polymeric  
composition to form a sleeve of predetermined shape;

inserting said vacuum interrupter with attached sleeve into a  
locating cavity of pre-determined shape in a pre-moulded polymeric  
15 housing; and,

mechanically securing therewithin said vacuum interrupter with  
attached sleeve.

If required said sleeve may be moulded by an injection moulding or  
compression moulding process.

20 Preferably said sleeve is moulded by a casting process with a  
flowable curable polymeric composition.

If required said sleeve may be comprised of a substantially rigid  
material.

Preferably said sleeve is comprised of an elastomeric material.

Suitably the polymeric composition has a dielectric strength in the range 10 to 30 kV/mm.

Said sleeve may extend over at least part of the axial length of the  
5 exposed surface of said vacuum interrupter.

Alternatively said sleeve may extend over one or more circumferential regions between opposed ends of the surface of said vacuum interrupter.

If required said sleeve may comprise one or more circumferential  
10 rib-like projections.

Said one or more circumferential rib-like projections may comprise a helical screw thread adapted to engage a complementary screw threaded surface within said cavity.

The outermost surface or surfaces of said sleeve are preferably  
15 adapted to be an interference fit in said locating cavity within said housing.

The cavity may comprise parallel inner side wall surfaces.

Preferably the cavity includes tapering inner side wall surfaces converging from a proximal end adjacent a mouth of said cavity to a distal  
20 end spaced therefrom.

The vacuum interrupter may be mechanically secured within said cavity by frictional engagement between said sleeve and an inner wall surface of said cavity.

Alternatively the vacuum interrupter may be mechanically secured in said cavity by an adhesive material.

Preferably the vacuum interrupter is mechanically secured in said cavity by axial tension applied by a screw threaded fastener extending via  
5 an aperture in the base of said cavity to a screw threaded terminal of a fixed switch contact of said interrupter.

According to another aspect of the invention there is provided an electrical switching device embodying a vacuum interrupter incorporated in an insulating body according to the abovedescribed method.

10

#### BRIEF DESCRIPTION OF THE DRAWINGS

In order to more fully understand the invention and put it into practical effect, reference will now be made to preferred embodiments in which:-

15 FIG 1 is a cross sectional view of a sleeve vacuum interrupter located within a cavity in a housing.

FIG 2 shows an alternative embodiment of the system of FIG 1.

FIG 3 shows yet another embodiment of the system of FIG 1.

FIGS 4-6 show still other embodiments of the system of FIG 1.

20 FIG 7 shows a further embodiment of the system of FIG 1.

FIG 8 shows a modified form of the invention.

#### DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

In FIG 1, a ceramic vacuum interrupter 1 of a conventional type has an integrally formed silicone rubber sleeve 2 having a generally cylindrical central portion 3 and a proximal locating rib 4 and a distal locating rib 5.

5           The interrupter/sleeve assembly 1, 2 is located in a cavity 6 in a pre-moulded insulating housing 7, the cavity having a frusto conical inner wall surface 8.

          The vacuum interrupter 1 is located radially within cavity 6 by means of engagement between ribs 4 and 5 and axially by means of a  
10   threaded stud 9 locating in the threaded socket 10 of a fixed switch contact of the interrupter via copper heat sink/conductor member 10a. Vacuum interrupter 1 is axially tensioned by a tubular nut 11 engaging stud 9.

          In the manufacture of sleeve 2, the outer ceramic wall surface of  
15   vacuum interrupter 1 is coated with a silane primer such as Wacker G 790 which is recommended for addition - crosslinking silicone polymers.

          After allowing the primer to dry at ambient temperature for about one hour or for about 15 minutes at 100°C, the vacuum insulator is located in a mould (not shown) to which is added a liquid room  
20   temperature vulcanizing (RTV) silicone rubber such as Wacker Powersil 600 - a two component addition curing compound.

          The monomer and catalyst are mixed in the required ratio and the mixture is submitted to a reduced pressure of less than 20 mbar to

remove any entrained air bubbles.

After deaeration, the liquid mixture is poured into the mould cavity and allowed to cure before removal from the mould.

The assembly, when removed from the mould has a void free  
5 interface between the sleeve and the ceramic surface of the interrupter. The high degree of adhesion thus achieved provides a degradation resistant electrical and mechanical integrity for the life of the interrupter.

The outer surface of ribs 4, 5 and/or the inner surface 8 of cavity 6  
of body 7 are then lubricated with a silicone oil or grease and the  
10 interrupter/sleeve assembly 1, 2 is pushed gently into cavity 6 with the fixed switch contact uppermost.

A threaded stud 9 is then inserted via aperture 12 in body 7 to engage the threaded socket 10 of the fixed switch contact.

A nut 11 is screwed on to stud 9 and gently tightened until it  
15 locates in its final resting place as shown.

The silicone rubber typically has a hardness of around 25 Shore A and when the vacuum interrupter is seated in its final resting place, ribs 4 and 5 have undergone a compression of about 6-12%, preferably 7.5-8.0% in radial thickness.

20 Depending upon the degree of taper in the cavity 6 and/or the configuration of sleeve 2, silicone rubbers having a hardness of from 15 Shore A to 65 Shore A may be employed.

By employing this method of manufacture, it is possible to test the

electrical integrity of housing 7 before final assembly and thereby avoid the prospect of discarding an entire assembly with a relatively expensive vacuum interrupter in the event that the housing is found to be faulty after moulding.

5           Moreover, in the event of a vacuum interrupter failure, it can be readily replaced without the expense of a complete assembly as with the prior art.

          It will be readily apparent to a skilled addressee that many modifications and variations may be made to the invention without  
10       departing from the spirit and scope thereof.

          For example, the preformed insulating housing body 7 is conveniently cast from a cycloaliphatic epoxy resin however it may be made from suitable known weather resistant thermoplastic or thermosetting resins by injection or compression moulding.

15           Alternatively body 7 may be cast, injection moulded, compression moulded or rotation moulded from a known curable polymeric compound such as a filled polyester resin.

          The pre-moulding process provides a smooth locating cavity 6 of high dimensional tolerances.

20           In other variations the shape of the locating cavity 6 and the configuration of sleeve 2 may be adapted to a wide range of shapes and features.

          FIG 2 shows an alternative embodiment in which the sleeve 2 of

silicone rubber comprises a tubular element having a frusto-conical outer surface generally complementary to that of inner wall 8.

FIG 3 shows a variation wherein sleeve 2 comprises a narrow rib located intermediate the ends of the ceramic wall of vacuum interrupter 1.

5 If required a channel-like recess 15 may be formed in the outer surface of rib 2 to form rib-like projections 16.

FIG 4 shows another embodiment wherein sleeve 2 is formed as a narrow rib adjacent the proximal end of interrupter 1.

10 In the case of the embodiments of FIGS 3 and 4, vacuum interrupter is firmly located in its recess 6 by tension on stud 9 and compressive engagement between the respective surfaces of sleeve 2 and wall 8.

FIG 5 shows a still further embodiment of the invention.

15 In this embodiment sleeve 2 and wall surface 8 are formed with complementary surfaces in the form of a coarse helical thread 17.

Sleeve 2 may be formed of hard or soft dielectric polymeric material and provides a substantially greater tracking path between the steel end caps of the vacuum interrupter.

20 To assist in locating the vacuum interrupter and in removal of air, the threaded surface of sleeve 2 may be lubricated with a high dielectric lubricant such as silicone oil or silicon grease.

The vacuum interrupter is driven home by a mechanical engagement with the fixed switch terminal socket or moulded lugs 18



formed on the proximal end of sleeve 2.

If removal of the vacuum interrupter for repairs or the like is not required, the lubricant may comprise a liquid curable adhesive composition.

5 If required, the helical thread surfaces on the sleeve 2 and the wall 8 may be formed as a tapered thread.

FIG 6 shows yet another embodiment of the invention.

In this embodiment, the vacuum interrupter is mechanically fastened into cavity 6 by means of stud 9 and nut 11 and thereafter a  
10 curable liquid polymeric material is poured into the void 19 between the ceramic surface of interrupter.

The polymeric material may comprise an elastomer or it may comprise a more rigid material.

FIG 7 shows still another embodiment in which a solid frusto-  
15 conical sleeve 2, of the same general configuration of the sleeve of FIG 2, has formed in its outer circumferential surface a plurality of spaced channels 13 which form a plurality of ribs 14 therebetween.

In still further variations of the invention the interrupter sleeve may be formed by a castable or mouldable polymeric compound having  
20 suitable dielectric, thermal and mechanical properties. Such compounds may include polyurethanes, silicone rubbers, acrylic elastomers, butyl rubbers, vinyl resins, ethylene resins, polyesters, polyethers, epoxy resins or the like or mixtures or copolymers thereof without limiting the invention.

The sleeve may be formed by casting with a liquid curable compound or by insert injection or compression moulding.

In some application, the sleeve 2 may be formed from a semi-conductive polymer or a combination of non-conductive and semi-conductive polymers.

FIG 8 shows a modified form of the invention wherein the vacuum interrupter 1 comprises a conventional ceramic or glass bodied device having a polyurethane sleeve 2 fitted as part of the manufacturing process.

In the embodiment shown the sleeved interrupter 1 is located within body 7 with an air space in cavity 6 between the outer surface 2a of polyurethane sleeve 2 and the inner wall 8 of body 7.

Interrupter 1 is supported axially in the body 7 by tension from tubular nut 11 on the threaded stud 9 located in the threaded socket 10 of the fixed switch contact of interrupter 1.

DATED this Sixth day of January 1999

~~FARALLON PTY LTD~~  
No-hcc Pty Ltd  
By its Patent Attorneys

FISHER ADAMS KELLY



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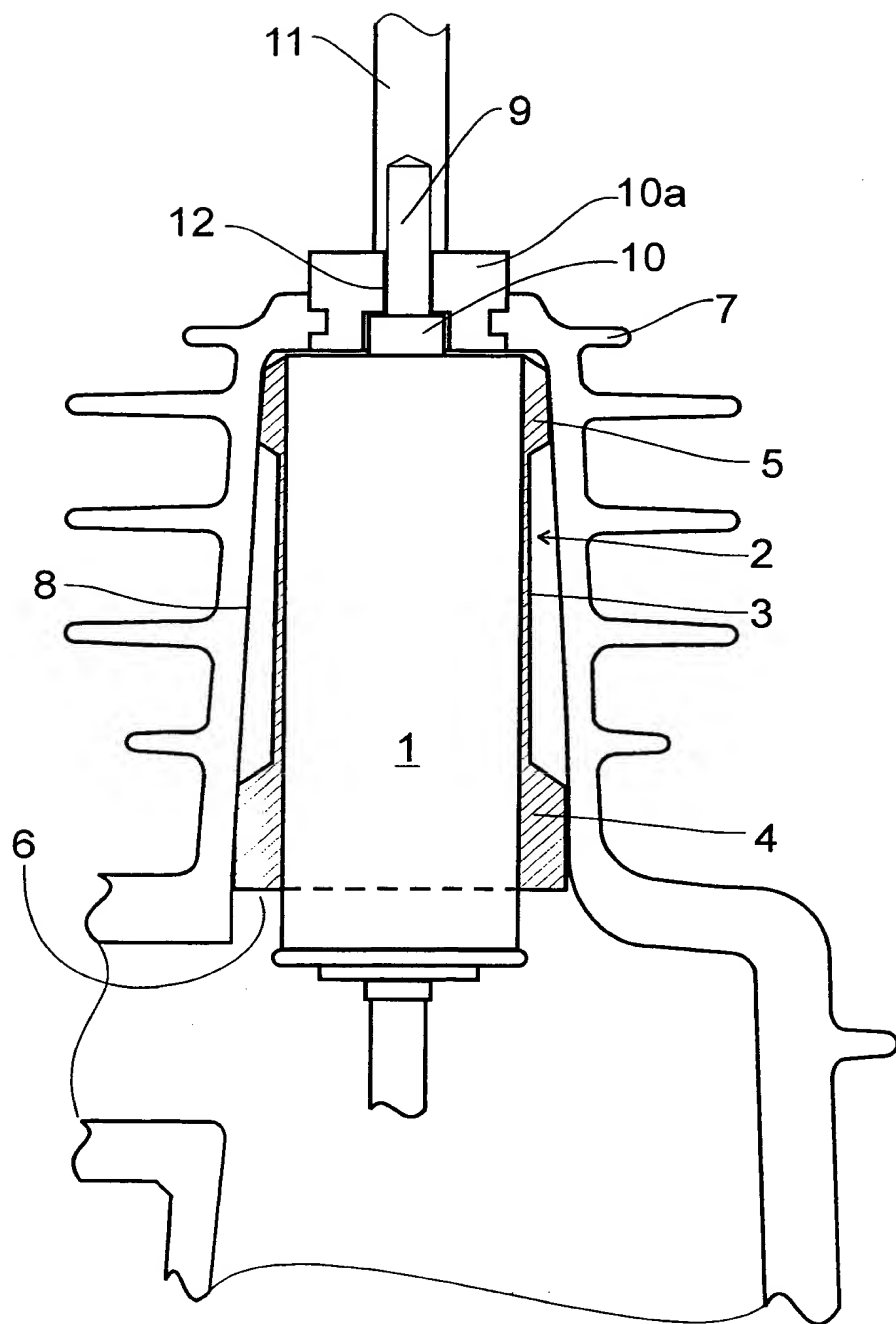


FIG. 1

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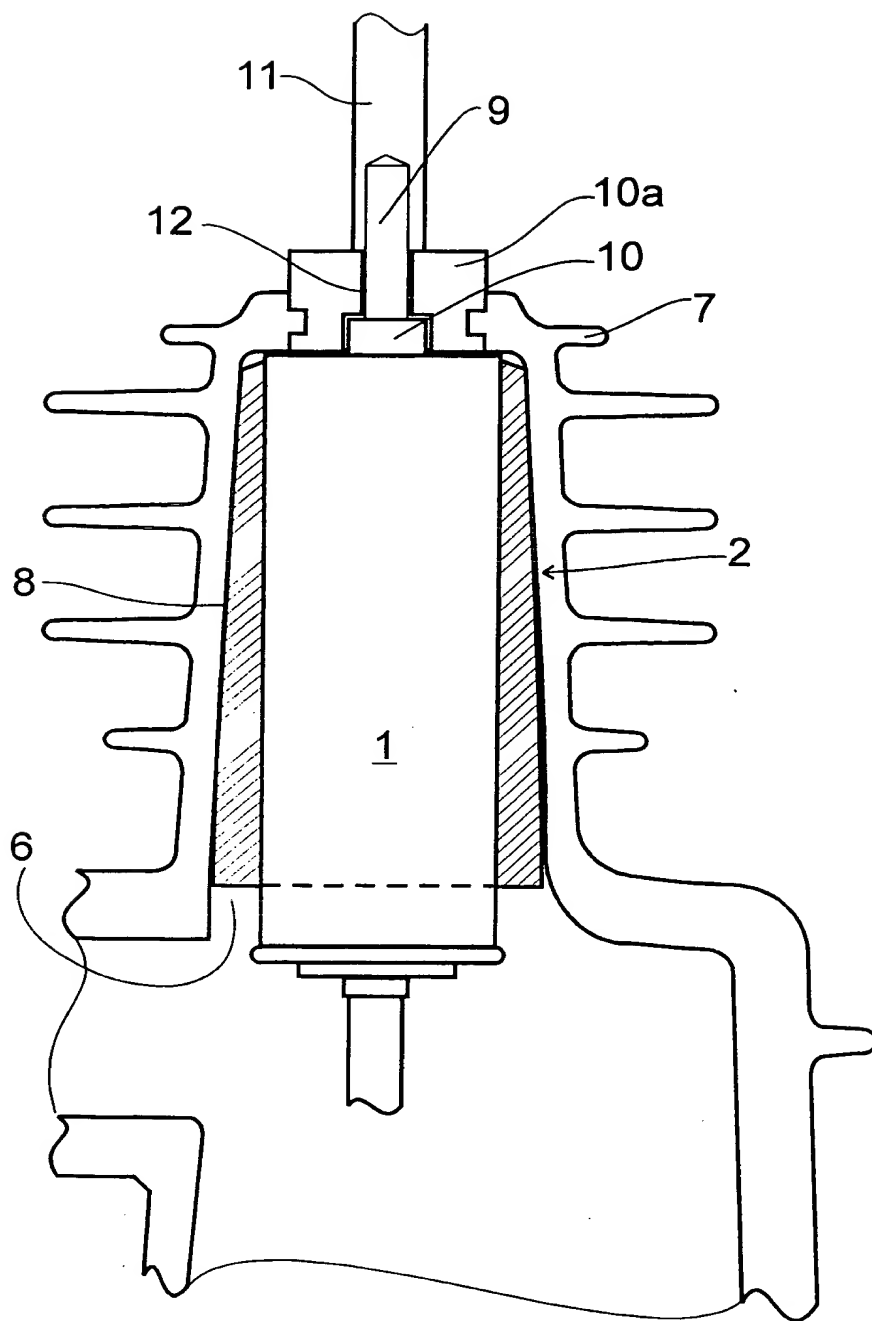


FIG. 2

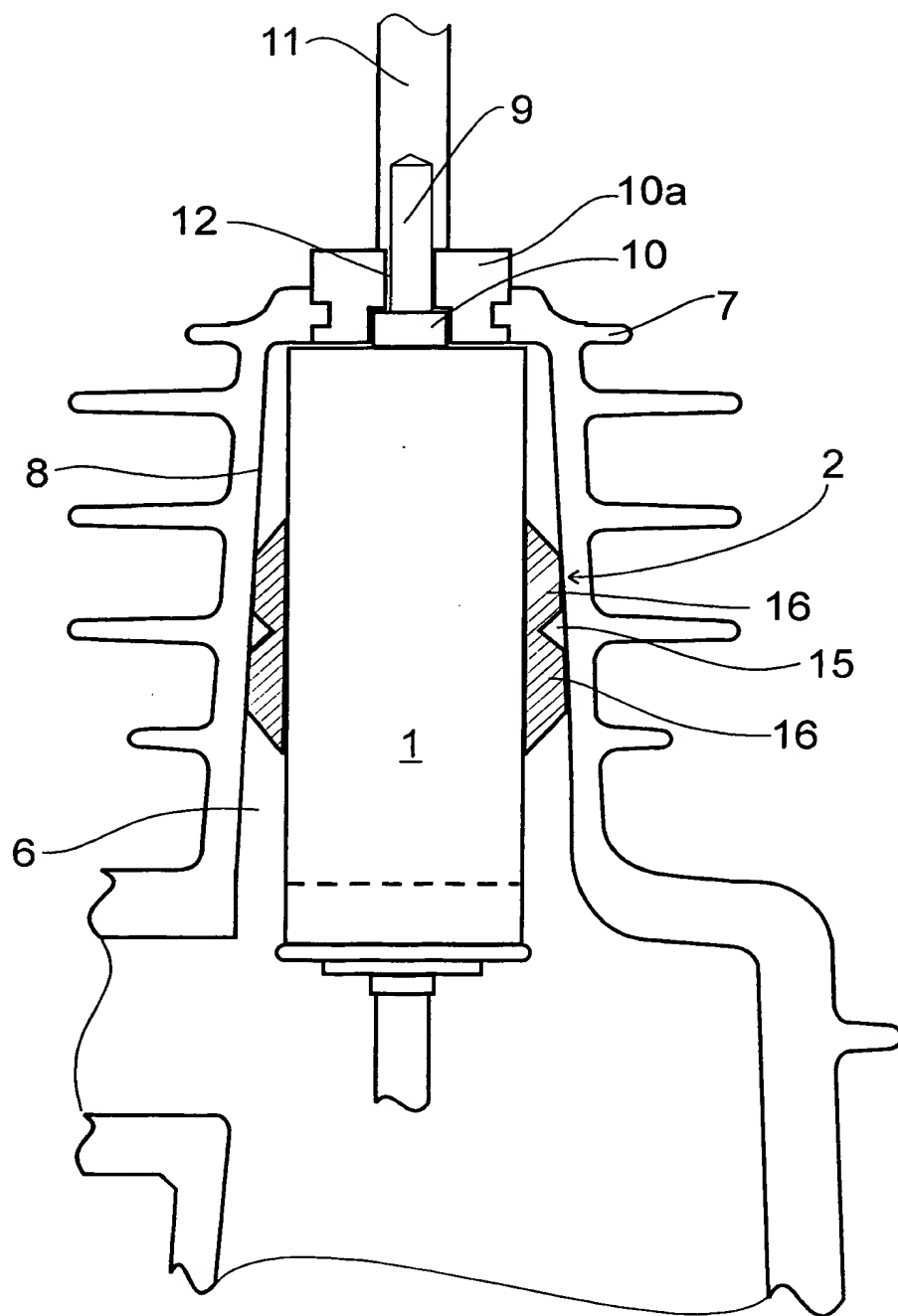


FIG. 3

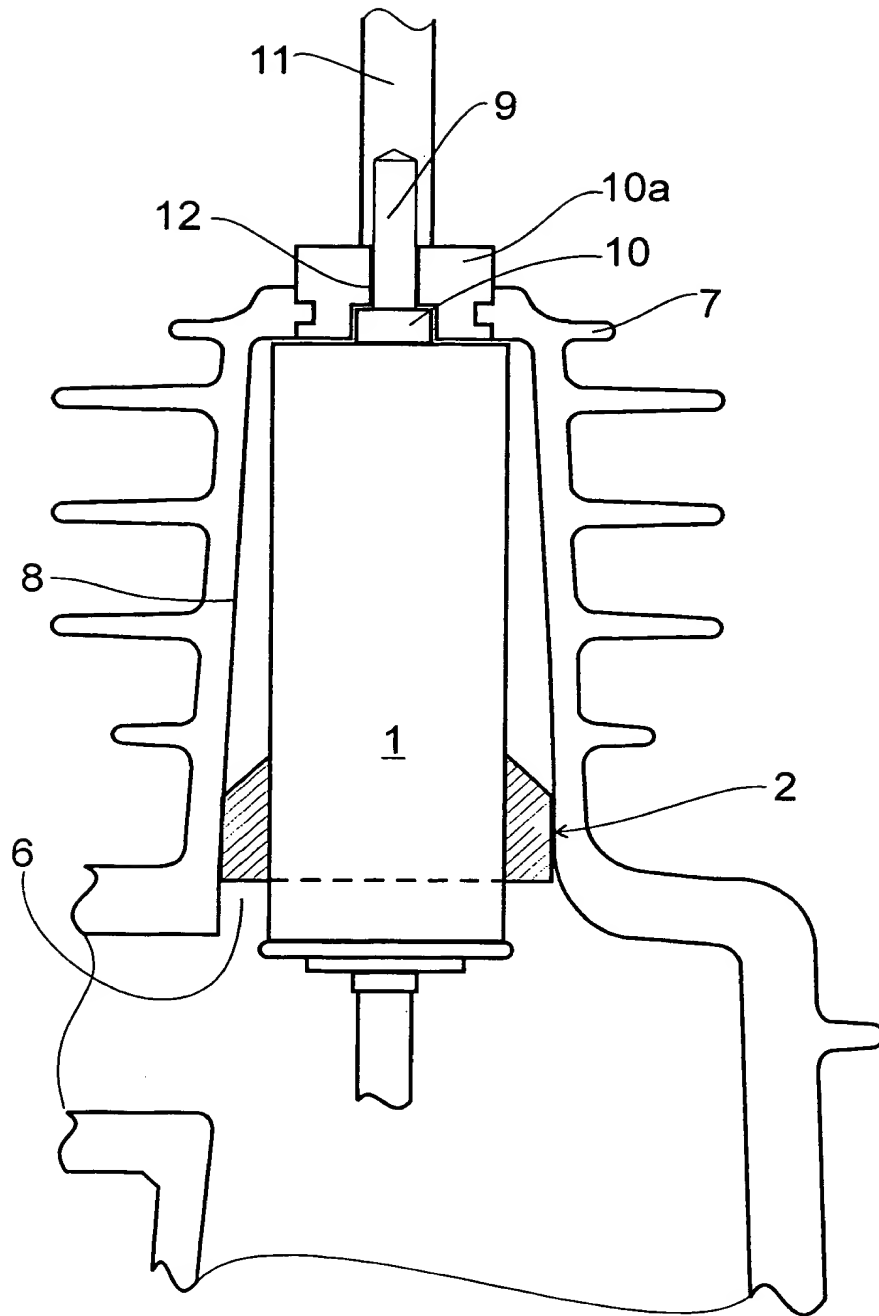


FIG. 4

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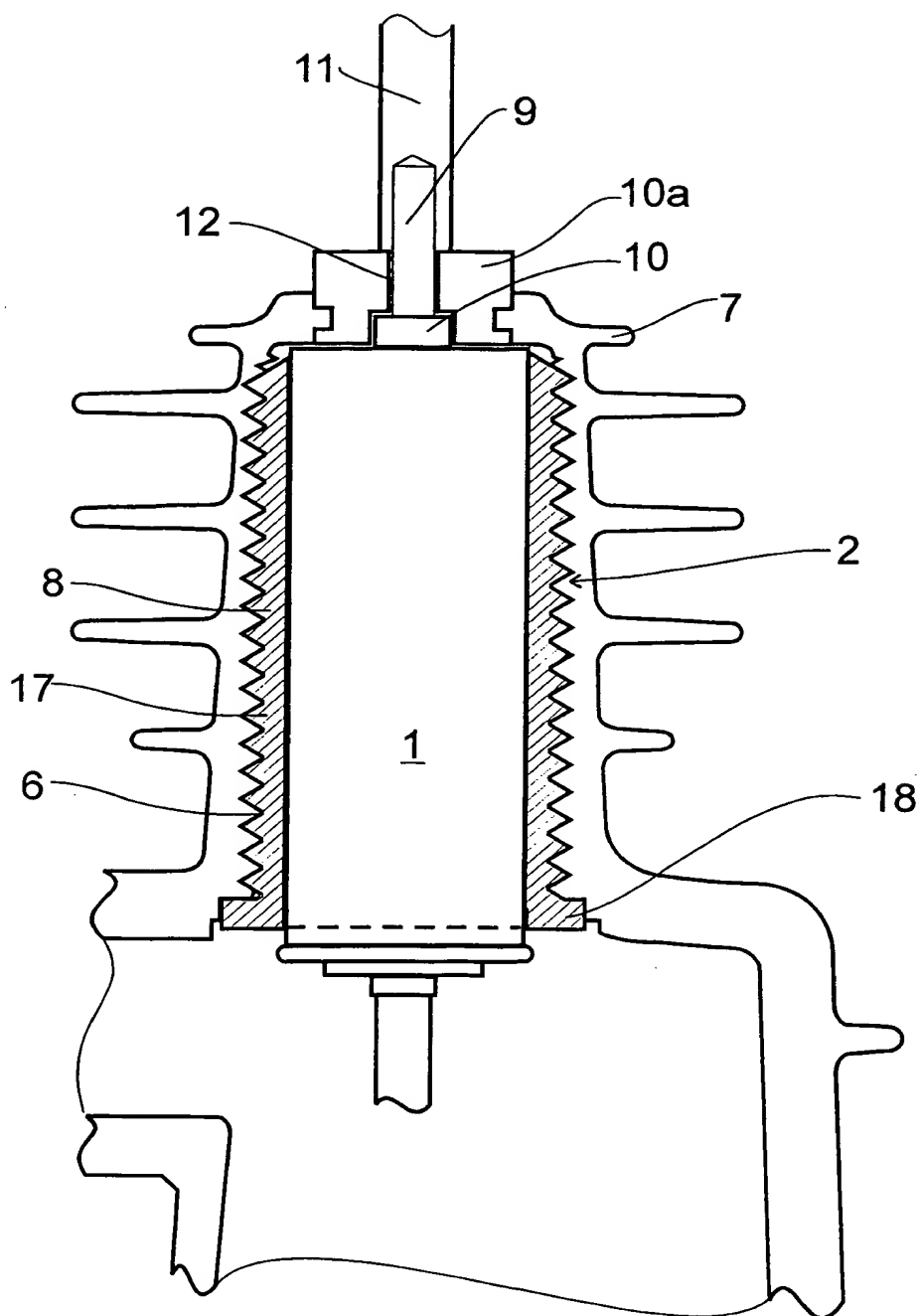


FIG. 5

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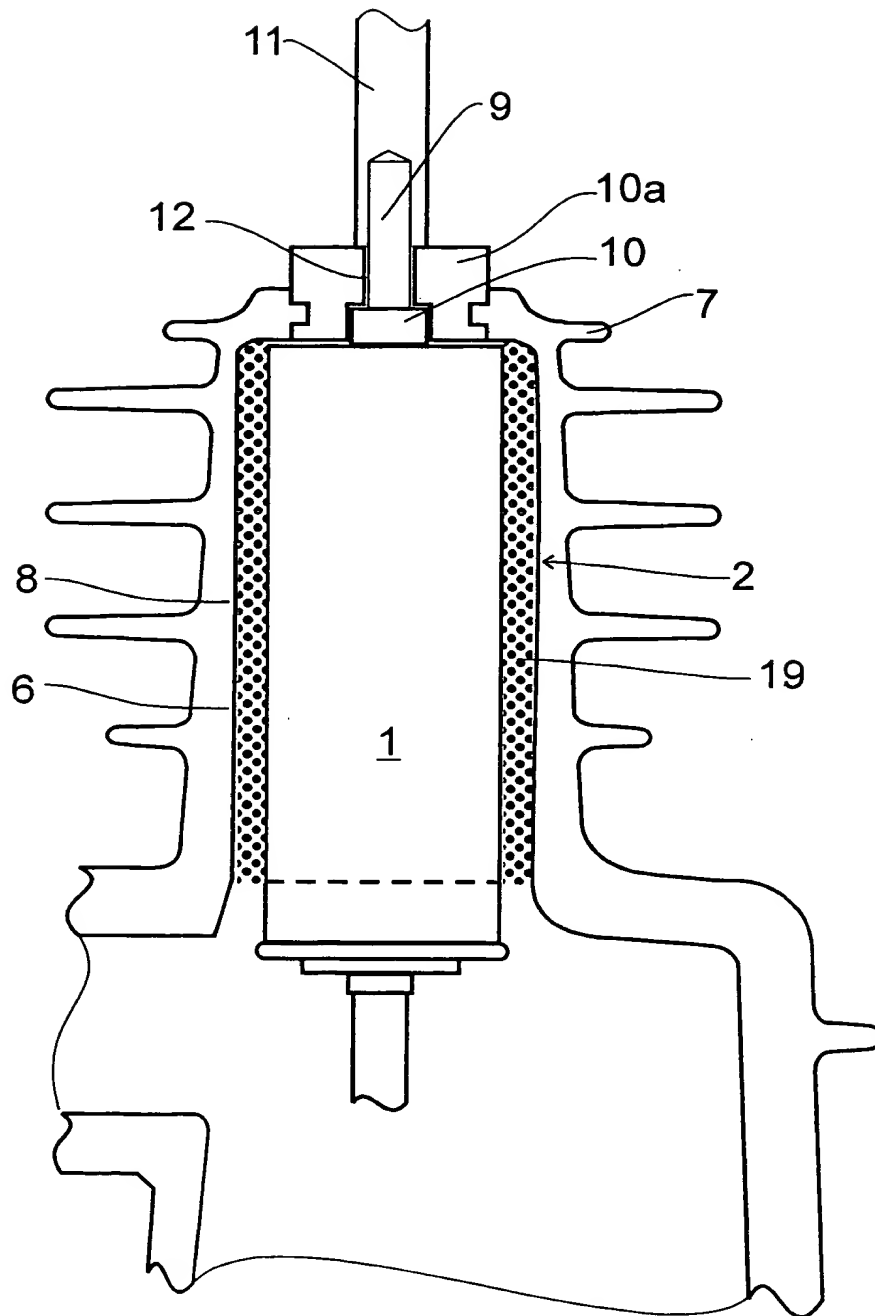


FIG. 6



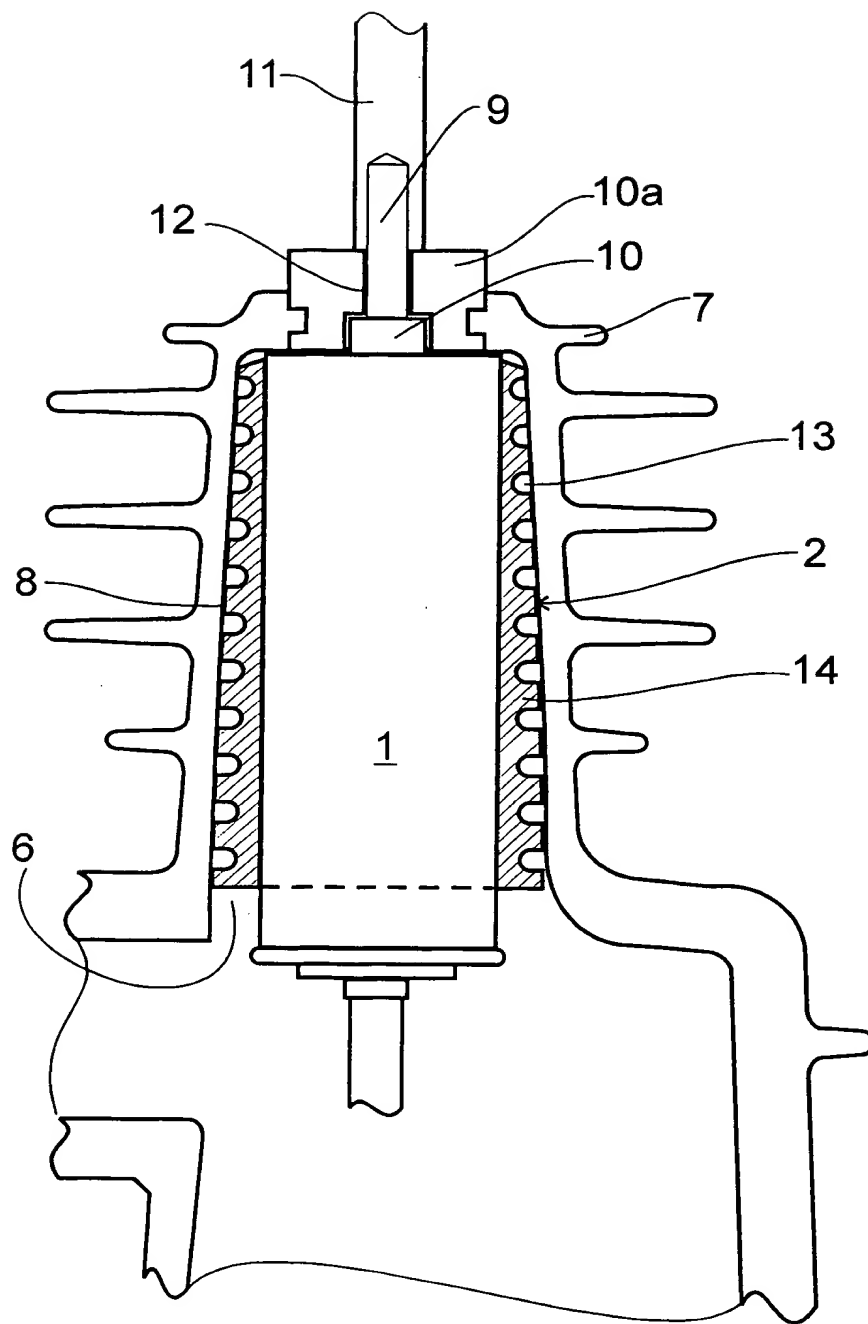


FIG. 7

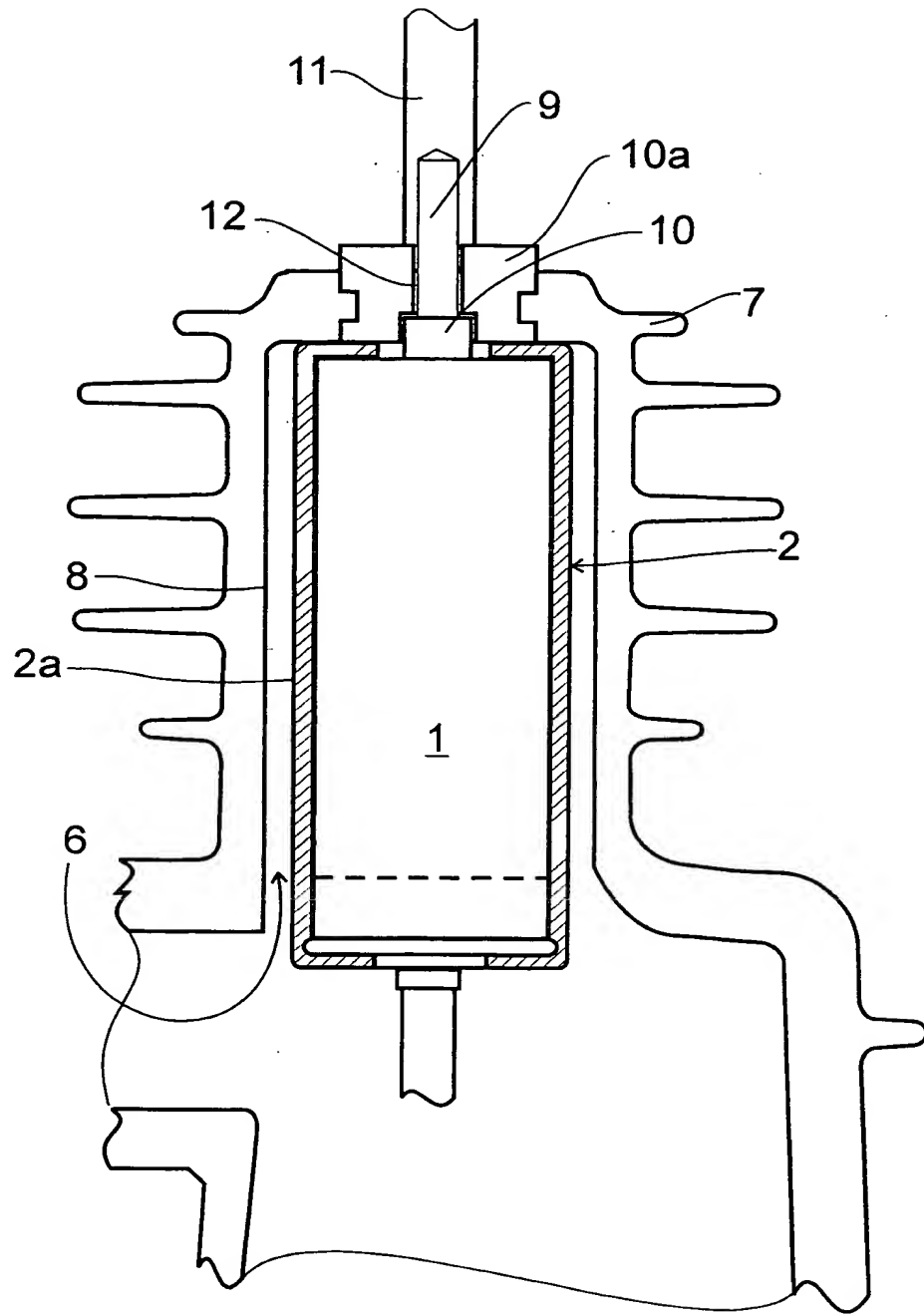


FIG. 8